Designing Operational Trials: Life Cycle and References

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Operational trials must be designed and implemented with great care and forethought if results are to be accurate and useful in making better management decisions.

There may be many definitions of what an operational trial is. But in the end, operational trials, research trials, experiments and adaptive management studies are all variations on a theme and a precise definition is surely not essential. All of these methods of looking for treatment differences have strengths and weaknesses but the fundamental principles underlying these strengths and weaknesses remain the same. For instance, randomization is always important, both when selecting study units and when assigning treatment levels to study units. Any study design, whether a sampling program, an observational study or a trial of some variety is stronger if randomization is possible and used. It is weaker if the appropriate randomization can't or wasn't implemented and must be presumed to have happened for data to be analyzed.

Statistical advice is best obtained early in the trial development since there are no 'magic bullets' which can repair a badly designed trial. Statistical advice is most relevant during stage 2) when designing the trial and stage 5) when analysing and interpreting the data.

We might ask the following questions while designing a trial:

1) What is the objective of our operational trial?
2) To what population do we want our trial results to be relevant?
3) What are the treatments and what controls will we have?
4) How big must the difference between the treatments or treatment and control be in order for us to change our management practice?
5) What are some of the possible outcomes and how do they affect the design and possible data analysis and interpretation?
6) What are some of the 'nuisance' variables that will affect our results?
7) How are we going to select members (i.e. study units) from the population?
8) How many study units will we use?
9) How will the treatment and 'nuisance' factors be assigned to the study units?
10) What variables measure the response we are interested in?
11) Must we subsample the study units to obtain a study unit response? And if so, how will we do that?
12) What form of analysis do we expect to run on the data?

Operational Trial Life Cycle and Corresponding Documentation

The "ideal" operational trial has a number of stages in its life cycle with appropriate documentation occurring at several of the stages. Well-documented operational trials have a greater potential for future unanticipated usefulness. While documentation can be a real pain and may appear unnecessarily onerous, doing it well is very important. Consider the following general principle: If the operational trial leader "got hit by a bus" would someone new to the project be able to bring the trial to the completion envisioned by the original trial leader? What

would you need to know if you were that "new" person? Reports do not need be to long and wordy – brief descriptions of what was done along with maps, photos and other useful pieces may be all that is necessary.

While individual operational trials may have additional stages, they should all have the following:

Trial Life Cycle Overview

TRIAL LIFE CYCLE STAGE	Documentation
1) IDENTIFY NEED FOR TRIAL: Identify an information gap and conduct an information/literature search to determine current information availability.	***Problem Analysis*** (formal report optional)
2) DESIGN: a) develop objective and b) design the trial. Careful thought and discussion with others knowledgeable in the subject area and in trial design can be very helpful. Good statistical support at this stage is important. Careless work here can completely undermine a trial regardless of how well the other stages are implemented.	***Working Plan***
3) ESTABLISH: put the plan into operation. Modifications to the original design/plan often occur here. If done incorrectly, usefulness of the study may be seriously undermined. Make sure that any such changes are noted. Preserve study by appropriately registering its existence.	***Establishment Report*** (may be unnecessary for "armchair" studies)
4) COLLECT DATA and MAINTAIN SITES: Check that trial site(s) are okay and note changes, such as deer browse levels, brush competition, etc. Collect interim measurements as scheduled and safely store. Check data for obvious errors since it is easier to find typing errors etc. now, rather than later.	***Project Diary*** Not a formal report but notes made here can be essential to interpreting study results
5a) ANALYSE: Collected data is "cleaned", summarized and analyzed.	Formal report possible but not necessary
5b) REPORT: Longer-running trials may benefit from interim reports which describe how the trial is progressing.	***Interim Report*** (optional)
5c) REPORT: Describe the outcome of the trial including relevant management implications. Results should be reported even if they are inconclusive or contrary to expected outcomes.	***Final Report***
6) COMMUNICATE: Disseminate trial results using workshops, WEB pages, extension notes, etc. Might archive final report and data in NRIN.	Whatever is appropriate
7) WRAP-UP: Ensure that there aren't any 'loose ends' pertaining to the trial site(s) or possible future data collections. Clearly identify what actions are necessary to terminate the trial or to undertake future site maintenance and re-measurement.	Designate site(s) for protection or release. Follow-up action plan. Exit evaluation for major projects.

Operational Trial Protocols

Biring, B.S., P.G. Comeau, J.O. Boateng, S.W. Simard. 1998. Experimental design Protocol for Long-Term Operational Response Evaluations (EXPLORE). Res. Br., Min. For., Victoria, B.C. Work. Pap. 31/1998. WEB site: http://www.for.gov.bc.ca/hfd/pubs/docs/wp/wp31.htm

Habitat Monitoring Committee. 1990. Procedures for environmental monitoring in range and wildlife habitat management. Draft edition version 4.1. B.C. Min. Environ. and B.C. Min. For., Victoria, B.C. 196 p.

Hays, W. 1990. Operational monitoring in the Prince George Forest Region. B.C. Min. For., Prince George Region, Prince George, B.C.

Herring, L.J. and J.C. Pollack. 1985. Experimental design protocol for forest vegetation management research: Level B trials (first approximation). B.C. Min. For. Internal Report (unpublished).

Leadem, Carole L, Sharon L Gillies, H Karen Yearsley, Vera Sit, David L Spittlehouse, Philip J Burton. 1997. Field Studies of Seed Biology. Res. Br., Min. For., Victoria, B.C. Land Mange. Handbook 40/1997.
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[NIVMA] Northern Interior Vegetation Management Association. 1990. Unified system of silviculture monitoring. Prince George, B.C.

[NIVMA] Northern Interior Vegetation Management Association. 1996. TRENDS: Treatment regime evaluation - Numerical decision support field manual. Prince George, B.C.

Pollack, J.C. and L.J. Herring. 1985. Experimental design protocol for forest vegetation management research: Level A trials (first approximation). B.C. Min. For. Internal Report (unpublished).

Silviculture Working Group. 1997. Growth and yield silviculture monitoring. Recommendations for sampling methods and a summary of main issues. Rep. To the Growth and Yield Monitoring Task Force Mesachie Lake meeting. June 17-19, 1997. B.C. Min. For., Victoria, B.C. (unpublished)

Simard, S.W. 1993. PROBE: Protocol for Operational Brushing Evaluations (First Approximation). B.C. Min. For., Victoria, B.C. Land Manage. Rep. No. 86.
WEB Site: Whole document not available but description is available at:
http://www.publications.gov.bc.ca/queries/ShowPubDetail.asp?PUB_Seq_Num=447531&PUB_Publication=7610000072

Thrower, J.S & Associates, Ltd. 1999. Interim report: Monitoring growth and yield of treated stands. Report prepared for B.C. Min. For., Resources Inv. Br. by J.S. Thrower & Associates Ltd.

General Statistical References

Cochran, William G., and Gertrude M. Cox. 1957. Experimental designs, 2nd ed. John Wiley & Sons, NY, NY, USA.
- a "bible" of balanced designs

Little, Thomas M., and F. Jackson Hills. 1978. Agricultural experimentation: Design and analysis. John Wiley & Sons, NY, NY, USA.
- a good straightforward introduction to trial design and data analysis.

Mead, R. R. N. Curnow and A. M. Hasted. 1993. Statistical methods in agriculture and experimental biology., 2nd ed. Chapman & Hall, NY, NY, USA
- general introduction to design and data analysis.

Snedecor, George W., and Wiliam G. Cochran. 1980. Statistical methods, 7th ed. The Iowa State University Press, Ames, Iowa, USA
- a good general compendium. May be newer editions out now.

Sokal, Robert R., and F. James Rohlf, 1981. Biometry, 2nd ed., W. H Freeman & Co., San Francisco, CA, USA.
– a good general compendium. Discusses ideas in some depth.

** Stafford, Susan G. 1985. A statistics primer for foresters. Journal of Forestry. pp 148-157.
– includes a very brief but excellent introduction to trial design.

Steel, Robert G. D., James H. Torrie, David A Dickey. 1997. Principles and procedures of statistics: A biometrical approach, 3rd ed., McGraw-Hill, NY, NY, USA
– a good general compendium

Wetherill, G. Barrie. 1981. Intermediate statistical methods. Chapman & Hall, NY, NY, USA
- more mathematical than "introductory" texts but much more readable than most non-introductory books.

Extra References

Hurlburt, Stuart H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs, 54(2), pp 187-211.

Johnson, Douglas H. 2002. The importance of replication in wildlife research. Journal of Wildlife Management. 66: 919-932.

Kish, Leslie. 1987. Statistical design for research. John Wiley & Sons. New York, NY.

Publications from the Biometrics Unit, Research Branch, BC Ministry of Forests

We have a WEB site at http://www.for.gov.bc.ca/hre/topics/biomet.htm. Most of our publications are available here.

a) Published Handbooks (all are available for download as PDF files).

Handbook #	Title
1	Pictures of linear models (1991)
2	Power analysis handbook for the design and analysis of forestry trials (1991)
3	Guidelines for the statistical analysis of forest vegetation management data (1992)
4	Catalog of curves for curve fitting (1994)
5	Analyzing ANOVA designs (1995)
6	Analysis of repeated measures and time series: an introduction with forestry examples (1996)
7	Introduction to logistic regression models with worked forestry examples (1996)

Also:

Sit, V. and B. Taylor (editors). 1998. Statistical methods for adaptive management studies, Res. Br., BC Min. For., Res. Br., Victoria, BC, Land Manage. Handb. No. 42. Web site: http://www.for.gov.bc.ca/hfd/pubs/docs/lmh/lmh42.htm

Bergerud, Wendy. 2002. The Effect of the Silviculture Survey Parameters on the Free-Growing Decision Probabilities and Projected Volume at Rotation. Res. Br., BC Min. For., Res. Br., Victoria, BC, Land Manage. Handb. No. 50. Web site: http://www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh50.htm

Planning and Implementing a Research study is available for download at: http://www.for.gov.bc.ca/hre/forprod/Research%20Project%20Protocols.pdf

b) Biometrics Pamphlets. These are also available for downloading as PDF files. The general WEB site is: http://www.for.gov.bc.ca/hre/biopamph/